Specification

This application is a national phase of PCT/JP2004/009128 that claims priority from Japanese patent application No. 2003-201079 filed July 24, 2003 and Japanese patent application no. 2003-338446 filed September 9, 2003.

Illumination optical equipment, exposure equipment and exposure method

Technical field

[0001] The present invention relates to illumination optical equipment, exposure equipment and an exposure method, and in particular relates to exposure equipment for manufacturing microdevices such as semiconductor elements, image pickup elements, liquid crystal display elements or thin film magnetic heads in a lithographic step.

Background art

[0002] In typical exposure equipment of this type, the optical flux that is emitted from the light source forms a secondary light source constituting a substantially planar light source comprising a large number of light sources, that are integrated by means of an optical integrator constituted by a fly-eye lens. The optical flux from this secondary light source is restricted by means of an aperture stop that is arranged in the vicinity of the downstream side focal plane of the fly-eye lens, before being input to a condenser lens.

[0003] The optical flux that is focussed by this condenser lens illuminates in superimposed fashion a mask that is formed with a prescribed pattern. After passing through the pattern of the mask, the light is imaged on a wafer, by means of a projection optical system. In this

way, the mask pattern is exposed by projection (i.e. transferred) onto the wafer. It should be noted that the pattern that is formed on the mask has a high density of integration and so it is indispensable to obtain a uniform illumination distribution on the wafer in order to accurately transfer this fine pattern onto the wafer.

Claims

[1] An optical system including an optically transparent member formed of crystalline material, characterized in that the direction of the fast axis relating to variation of birefringence of said optically transparent member when subjected to optical illumination is set to be substantially coincident with or substantially orthogonal to the direction of oscillation of the electrical field of linearly polarized light incident on said optically transparent member.

[2] Optical illumination equipment comprising an optical system according to claim 1, characterized in that the surface to be illuminated is illuminated with light through this optical system.

[3] Optical illumination equipment including an optically transparent member formed of crystalline material of the cubic system, wherein a surface to be illuminated is illuminated with light through this optically transparent member, characterized in that:

the direction of propagation of the light in said optically transparent member is set so as to be closer to the crystal orientation < 111 > or crystal orientation < 100 > than to crystal orientation < 110 >.

[4] The optical illumination equipment according to claim 3, characterized in that said optically transparent member comprises an optical member that is fixedly located in position in the optical path and the optical axis of said optical member is set so as to substantially coincide with the crystal orientation < 111 > or crystal orientation < 100 >.

[5] The optical illumination equipment according to claim 3, characterized in that said optically transparent member comprises a prism and the input face and output

face of said prism are set so as to substantially coincide with the crystallographic plane {100}.

[6] The optical illumination equipment according to claim 3, characterized in that said optically transparent member comprises a prism and the input face and output face of said prism are set so as to substantially coincide with the crystallographic plane {111}.

[7] The optical illumination equipment according to claim 3, characterized in that said optically transparent member comprises a prism and one of the faces of the input face and output face of said prism is set to substantially coincide with the crystallographic plane {111} and the other face thereof is set to substantially coincide with the crystallographic plane {100} or the crystallographic plane {211}.

[8] The optical illumination equipment according to claim 3, characterized in that said optically transparent member comprises a right-angled prism constituting an internal-face reflecting mirror and a reflecting face of said right-angled prism is set to substantially coincide with the crystallographic plane {100} and the plane defined by the optical axis of the input face of said right-angled prism and the optical axis of the output face of said right-angled prism is set so as to substantially coincide with the crystallographic plane {110}.

[9] The optical illumination equipment according to claim 3, characterized in that said optically transparent member comprises a right-angled prism constituting an internal-face reflecting mirror and the reflecting face of said right-angled prism and the plane defined by the optical axis of the input face of said right-angled prism and the optical axis of the output face of said right-

angled prism are set to substantially coincide with the crystallographic plane {110}.

[10] The optical illumination equipment according to claim 3, characterized in that said optically transparent member comprises a parallel planar plate for parallel displacement of a light ray that is incident along said optical axis, provided in said optical path in a manner capable of being tilted with respect to the optical axis and in that the optical axis of said parallel planar plate is set so as to substantially coincide with the crystal orientation < 100 >.

[11] The optical illumination equipment according to claim 10, characterized in that said parallel planar plate is capable of being tilted in a direction from crystal orientation < 100 > towards crystal orientation < 111 >.

[12] The optical illumination equipment according to claim 3, characterized in that said optically transparent member comprises a parallel planar plate for parallel displacement of a ray incident along said optical axis, provided in said optical path in a manner capable of being tilted with respect to the optical axis and in that the optical axis of said parallel planar plate is set so as to substantially coincide with the crystal orientation < 111 >.

[13] The optical illumination equipment according to claim 12, characterized in that said parallel planar plate is capable of being tilted from the crystal orientation < 111 > towards the crystal orientation < 100 >.

[14] The optical illumination equipment according to ~~any of~~ claim~~s~~ 10 ~~to 13~~, characterized in that said optically transparent member comprises a first parallel planar plate capable of being tilted about a first axis

and a second parallel planar plate capable of being tilted about a second axis substantially orthogonal to said first axis.

[15] The optical illumination equipment according to ~~any of~~ claim~~s~~ 3 ~~to 14~~, characterized in that the direction of the fast axis relating to variation of birefringence of said optically transparent member when subjected to optical illumination is set so as to be substantially coincident with or substantially orthogonal to the direction of oscillation of the electrical field of the linearly polarized light that is incident on said optically transparent member.

[16] The exposure equipment comprising optical illumination equipment according to ~~any of~~ claim~~s~~ 2 ~~to 15~~, characterized in that the pattern of a mask arranged at said surface to be illuminated is exposed onto a photosensitive substrate.

[17] An exposure method, characterized in that a mask is illuminated through optical illumination equipment according to ~~any of~~ claim~~s~~ 2 ~~to 15~~ and in that a pattern formed on said illuminated mask is exposed onto a photosensitive substrate